

CLAIMS

1. A method for producing a porous material comprising the steps of;
  - (a) providing a C/W emulsion comprising an aqueous phase, a matrix building material, a surfactant and a liquid CO<sub>2</sub> phase;
  - (b) at least partially freezing the aqueous phase;
  - (c) gasifying CO<sub>2</sub> from the liquid CO<sub>2</sub> phase to produce an intermediate porous material;
  - (d) venting the gasified CO<sub>2</sub> from the intermediate porous material:  
and
  - (e) freeze drying the intermediate porous material at least substantially to remove the aqueous phase and to form the porous material.
2. A method for producing a porous material as claimed in claim 1, wherein the emulsion further comprises a dopant.
3. A method for producing a porous material as claimed in claim 2, wherein the dopant is substantially water-soluble.
4. A method for producing a porous material as claimed in claims 2 or 3, wherein the dopant is selected from one or more of the following dopants: pharmaceutical actives, pharmaceutical salts, enzymes, dyes, oxidising agents, reducing agents, cleaning agents, reagents for organic synthesis, agrochemicals, fabric softeners, clothes care agents, bleaches, flavours, fragrances, vitamins or nutraceuticals, metal nanoparticles (*e.g.*, metal hydrosols), inorganic nanoparticles, biological polymers (*e.g.*, DNA, RNA), growth factors/cofactors, and live cells (*e.g.*, stem cells).

5. A method for producing a porous material as claimed in any one of claims 1 to 4, wherein a substantially water-soluble inorganic or organic additive is additionally used.

6. A method for producing a porous material as claimed in claim 5, wherein the additive is selected from one or more of the following additives: partially hydrolysed silica precursors (*i.e.*, a silica 'sol'), other alkoxide sols, hydroxyapatite salts, and sodium silicate.

7. A method for producing a porous material as claimed in any one of claims 1 to 6, wherein the matrix building material is a polymeric material.

8. A method for producing a porous material as claimed in claim 7, wherein the polymeric material is substantially free of cross-linking.

9. A method for producing a porous material as claimed in any one of claims 1 to 6, wherein the matrix building material is a vinyl polymer material.

10. A method for producing a porous material as claimed in any one of claims 1 to 6, wherein the matrix building material is selected from one or more of the following group of materials: poly(vinyl alcohol), dextran, sodium alginate, poly(aspartic acid), poly(ethylene glycol), poly(ethylene oxide), poly(vinyl pyrrolidone), poly(acrylic acid), poly(acrylic acid)-sodium salt, poly(acrylamide), poly(*N*-isopropyl acrylamide), poly(hydroxyethyl acrylate), poly(acrylic acid), poly(sodium styrene sulfonate), poly(2-acrylamido-2-methyl-1-propanesulfonic acid), polysaccharides, and cellulose derivatives.

11. A method for producing a porous material as claimed in any one of claims 1 to 10, wherein the matrix building material is substantially water-soluble.

12. A method for producing a porous material as claimed in any one of claims 1 to 11, wherein the temperature of the emulsion is reduced to a temperature in the range of  $-5^{\circ}\text{C}$  to  $-30^{\circ}\text{C}$ .

13. A method for producing a porous material as claimed in any one of claims 1 to 12, wherein the  $\text{CO}_2$  is gasified by means of depressurisation of the intermediate porous material.

14. A method for producing a porous material as claimed in any one of claims 1 to 13, wherein the surfactant is selected from one or more of the following list of surfactant: CTAB (cetyltrimethylammonium bromide), SDS (sodium dodecyl sulphate), pluronic surfactants, Brij 30 and Tween 40.

15. A method for producing a porous material as claimed in any one of claims 1 to 14, wherein the matrix building material is contained within the aqueous phase of the emulsion.

16. A method for producing a porous material as claimed in any one of claims 1 to 15, wherein the constituents of the emulsion are in the following quantities: the matrix building material is in the range of 5-20 % w/v and the surfactant is in the range of 5-20 % w/v in respect of  $\text{H}_2\text{O}$  and the  $\text{CO}_2$  is in the range of 65-95 % v/v.

17. A method for producing a porous material as claimed in any one of claims 1 to 16, wherein the porous material is produced in the form of a monolithic block.

18. A method for producing a porous material as claimed in any one of claims 1 to 17, wherein the porous material is produced in the form of porous particles or beads.

19. A method for producing a porous material as claimed in any one of claims 1 to 18, wherein the emulsion further comprises an active ingredient for incorporation into the porous material.

20. A method for producing a porous material as claimed in claim 19, wherein the active ingredient is selected from one or more from the following group; pharmaceutical actives, pharmaceutical salts, enzymes, dyes, oxidising agents, reducing agents, cleaning agents, reagents for organic synthesis, agrochemicals, fabric softeners, clothes care agents, bleaches, flavours, fragrances, vitamins or nutraceuticals, metal nanoparticles (*e.g.*, metal hydrosols), inorganic nanoparticles, biological polymers (*e.g.*, DNA, RNA), growth factors/cofactors, and live cells (*e.g.*, stem cells).

21. A porous material obtainable by the method as claimed in any one of claims 1 to 20.

22. A porous material according to claim 21, which is water-soluble.

23. A water-soluble porous material according to claim 22, wherein the material is characterised by having

- (a) a median pore diameter within the range of 5–100 microns;
- (b) a total pore volume in the range of 8–15 cm<sup>3</sup>/g when approximately 80% v/v CO<sub>2</sub> is used; and
- (c) a bulk density typically in the range 0.02–0.06 g/cm<sup>3</sup>.

24. A water-soluble porous material according to any one of claims 21 to 23, characterised by having substantially no solvent residue remaining in the material that arises from the internal template phase.

25. A water-soluble porous material according to any one of claims 21 to 24, being produced in the form of a moulded, monolithic block that substantially conforms to the shape of a vessel in which it is produced.

26. A porous material comprising a water-soluble polymeric matrix, which matrix comprises substantially no residual organic solvent.

27. A porous material according to claim 26 obtainable by a method which utilises substantially no organic solvent, hence the matrix being substantially free from any residual organic solvent component.

28. A porous material according to claim 26 or claim 27 comprising surfactant moieties entangled with the polymeric matrix.

29. A porous material according to claim 28, wherein the presence of surfactant moieties results from the formation of the porous material from a C/W emulsion comprising the surfactant moieties.

30. A porous material as claimed in any one of claims 21 to 29, wherein the material is used for one or more of the following applications: biomaterials, tissue supports, food materials, tissue scaffolding, DNA storage, absorbent, controlled release matrices, scaffolds for sensor materials, wound-healing matrices, agrochemical release, reagent release (*e.g.*, for chemical reactions), scaffold for combinatorial chemistry, molecular separations and diagnostic reagent release.